CHBE 301 Syllabus

Introduction to Chemical Engineering Analysis
Mass and Energy Balances

Fall Semester 2012
MWF 10-10:50am
106 Space Science and Technology Building

Description:

- Use of basic mathematical concepts, physical laws, stoichiometry, and the thermodynamic properties of matter to obtain material and energy balances for steady and unsteady state systems. Required for sophomores intending to major in chemical engineering.
- This course serves as foundation for all other courses in Chemical and Biomolecular Engineering.
- This course designed for sophomore students.

Course prerequisite(s) as listed in the General Announcements:

Math 101/102, CHEM 121/122; Co-requisite: CHBE 303

Objectives:

To introduce students to the principles and calculation techniques used in the field of Chemical Engineering, specifically you should be able to:
• Convert written descriptions of processes into graphical form, such as flowcharts
• Derive material and energy balances as applied to chemical engineering from either written descriptions or flowcharts
•Perform degree of freedom analyses to know when you have sufficient information with which to solve a problem
• Practice defining problems, collecting data, and analyzing data

We will introduce the principles of Chemical Engineering through the use of several case studies: the design of an apheresis process to separate blood into its component parts, the design of a high fructose corn syrup plant, the development of a strategy to control medically beneficial or harmful drug levels in the human body, formulation of advanced drug delivery systems, and the design of an artificial kidney. We will discuss several environmental issues dealing with the fate of toxic chemicals released into the air and into the groundwater system.

You are expected to complete reading assignments before each lecture period and to participate in classroom discussion.

Instructor:

Sibani Lisa Biswal
Abercrombie B240
Email: biswal@rice.edu
Phone: x6055
Office Hours: Friday 10:00am – 12:00pm and by appointment

Required Course Materials:

* Elementary Principles of Chemical Processes, 3rd Edition, Richard M. Felder and Ronald W. Rousseau, Wiley and Sons, Inc., New York, 2005, ISBN 0-471-68757-X (includes CD and workbook).

* Online Homework E-book: www.saplinglearning.com

1. Go to http://saplinglearning.com
2. a. If you already have a Sapling Learning account, log in, click "View Available Courses", then skip to step 3.
   b. If you have Facebook account, you can use it to quickly create a SaplingLearning account. Click "create account" located under the username box, then click "Login with Facebook". The form will auto-fill with information from your Facebook account (you may need to log into Facebook in the popup window first). Choose a password and timezone, accept the site policy agreement, and click "Create my new account". You can then skip to step 3.
   c. Otherwise, click "create account" located under the username box. Supply the requested information and click "Create my new account". Check your email (and spam filter) for a message from Sapling Learning and click on the link provided in that email.
3. Find your course in the list (listed by school, course, and instructor) and click the link.
4. Select your payment options and follow the remaining instructions.
5. Once you have registered and enrolled, you can log in at any time to complete or review your homework assignments.

During sign up - and throughout the term - if you have any technical problems or grading issues, send an email to support@saplinglearning.com explaining the issue. The Sapling support team is almost always more able (and faster) to resolve issues than your instructor.

Homework/ Examination/ Grading Policy:

Homework 20%
Project 20%
Two Midterms 30%
Final 25%
Participation 5%

A **50% penalty** will be assessed for **late** homework; no homework will be accepted once the solutions have been posted.

You **may not** refer to previous years homework/solutions/exams.

You may work with your classmates on homework sets but ultimately you must turn in your own work. You are NOT allowed to copy a classmate's homework directly ask or give your homework to a classmate to "consult".

Homework Guidelines:

-Homework must be submitted on 8.5"x11" paper, one side per page.
-All pages should be numbered, placed in chronological order, and contain your first and last name on the upper right side of the first page.
− Homework should be neat and legible. Points may be taken off if the TAs cannot read your answers.
-Multiple pages should be secured by staple or paper clip and not folded.
-Each solution should a list of assumptions, a diagram (if appropriate), and a solution containing adequate steps and explanations to ensure understanding of your solution by the instructor. The **final solutions to a homework problem must be boxed and include the correct units** or otherwise distinguished from the remainder of the problem. Solutions should be presented in a logical manner with commentary describing your process. No credit will be given if you only write down the final answer.
− Properly reference any material that you use and justify all assumptions clearly.

- Problems solved using a computer must contain all information required to reproduce your solution. Among other things, this means a spreadsheet printout only containing numbers is not sufficient. The formulas used must be included on the printout. All numbers must be identified and labeled with appropriate units. You must submit the data file for problems solved with computers by email in addition to submitting printouts and written work.

Homework and exam problems will be graded based on the following factors: correct assumptions, correct diagrams, legibility, clarity, neatness, identification of paper, clearly defined answer, correct approach to problem, and the correct answer.

Honor Code:

Academic dishonesty will not be tolerated. Failure to comply with the University's policy will result in an automatic "F" for CHBE 301.
**http://honor.rice.edu/index.cfm

Web Page:

This course uses Owl Space. Please go to: http://owlspace-ccm.rice.edu/
The page includes:
Copies of problem sets and problem set solutions
Announcements
Your grades
Contact information

Course Outline:

I. Introduction to Engineering Analysis
• What is chemical engineering?
• Problem definition and "how to get started" on a general problem
• Dimensions, units and conversions
• Process and process variables
• Chemical compositions, temperature, and pressure measurements; manometer applications
• Chemical reaction terminology and applications: stoichiometry, limiting reactant, % excess reactant, degree of conversion

II. Materials Balances
• Basic types: mass, elemental and chemical components
• Single unit: reactive and non-reactive
• Multi-unit non-reactive processes: bypass, recycle, and purge
• Multi-unit processes with reactions: bypass, recycle, and purge

III. Property of Materials
• Ideal gases: pure and mixed; with applications to material balances
• Real gases: pure and mixed; with applications to material balances (focus on z factors but introduce equations of state, and trial-and-error solutions)
• Vapor pressure: Antoine and Clausius-Clapeyron equations; Cox charts and steam tables
• Gas-vapor mixtures: relative saturation, relative humidity, dew point temperature, dew point pressure, condensation, saturation and drying problems
• Vapor-liquid equilibrium: Raoult's Law

IV. Energy Calculations
• Calculations of potential, internal, kinetic and enthalpy changes; using polynomial Cp, phase changes, thermodynamic charts, etc.
• Non-reactive energy balances: open steady-state turbines, heat exchangers, throttle valves, and filling and emptying of vessels

• Reactive energy balances: mostly open steady-state systems, including multiple reactions with arbitrary feed and conversions and temperatures
• Steady-state mechanical energy balance with Bernoulli's equation
• Introduction to 1st law of thermodynamics

V. Unsteady-state Material and Energy Balances

VI. Introduction to Scaling Analysis